

(19)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11)

EP 1 030 340 A2

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:

23.08.2000 Bulletin 2000/34

(51) Int Cl.7: H01J 17/49

(21) Application number: 99310058.5

(22) Date of filing: 14.12.1999

(84) Designated Contracting States:

AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE

Designated Extension States:

AL LT LV MK RO SI

(30) Priority: 19.02.1999 JP 4083799

30.06.1999 JP 18460999

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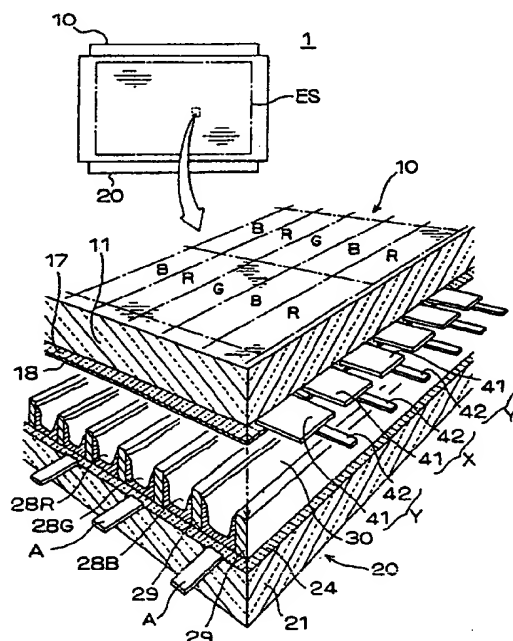
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### (54) Plasma display panel

(57) A plasma display panel is provided in which color temperature of the displayed color can be optimized while securing the gradation reproducibility and the stability of driving. The plasma display panel includes a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes, and each pixel of matrix display has first, second and third cells having different light colors. At least one of the effective area of the main electrode, the thickness of the dielectric layer, the relative dielectric constant of the dielectric material, and the area of the light shield for the first cell is different from that of the second cell.

Fig. 1



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## Description

**[0001]** The present invention relates to a plasma display panel (PDP) that can perform color display.

**[0002]** PDPs are becoming widely available as wide screen displays for television sets since color displays have become commercially successful. One of the challenges to improve the image quality of the PDP is to enhance reproducible color range.

**[0003]** As a color display device, an AC type PDP having three-electrode surface discharging structure is commercialized. This type has a pair of main electrodes for sustaining, which are arranged in parallel for each line (row) of the matrix display and also has an address electrode for each column. Division walls for preventing interruption of discharge between cells are provided in stripes. A surface discharging structure includes a substrate on which the pairs of main electrodes are arranged and an opposing substrate on which a fluorescent layer for color display is arranged, so that deterioration of a fluorescent layer due to an ion impact upon discharge can be reduced to obtain a longer life. The "reflection type" that has the fluorescent layer on the back substrate is superior to the "transparent type" that has the fluorescent layer on the front substrate concerning light emission efficiency. In general, Penning gas containing neon (Ne) and a trace of xenon (Xe)(4-5%) is used as a discharging gas. When the discharge between main electrodes occurs, the discharging gas radiates ultraviolet rays, which excite the fluorescent material to emit light. Each pixel includes three cells for red (R), green (G) and blue (B) light colors, and the ratio of the three light colors decide the display color. The amount of light emission of each cell depends on the number of discharge times per unit time.

**[0004]** The conventional PDP has a problem in that the color temperature of white is low compared with other displays (especially with a CRT). The reason is that the light intensity of the blue fluorescent material is lower than the light intensities of the red and the green fluorescent materials, and that neon as the discharging gas emits orange light.

**[0005]** It is necessary to optimize the relative light intensities (balance of luminous intensities) of the R, G and B cells for obtaining a desired color tone when trying to display white color by applying the same number (the maximum number within variable range) of voltage pulses to the R, G and B cells.

**[0006]** There is a method for adjusting the luminous intensity, in which a conversion efficiency of the fluorescent material and the thickness or the shape of the fluorescent layer is selected. However, this method has the following problems.

- 1) It is not easy to adjust the conversion efficiency of the fluorescent material.
- 2) The thickness or the shape of the fluorescent layer can be adjusted only within a range that does not

affect the discharge.

3) The control of the thickness and the shape of the fluorescent layer has low repeatability.

**[0007]** In addition, in order to set the number of voltage pulses to apply, that is, the number of discharges for each color so as to display white color having a desired tone, the number of voltage pulses for the color with the minimum intensity should be maximized and the number of voltage pulses for other colors should be smaller than that. Therefore, the variable range of the light emission amount is narrowed, resulting in deterioration of the gradation reproducibility.

**[0008]** Furthermore, there is another method in which the area of the fluorescent layer is selected for each color. In this method, stable driving is difficult since the size of the cell depends on the color, and the margin of the driving voltage is narrowed. Namely, if the size of pixel is fixed when the cells have different sizes, the cell size of at least one color becomes small compared with the cell size that is the same for three colors. Since the firing potential rises when the cell size is reduced, the voltage margin is narrowed.

**[0009]** Embodiments of the present invention aim to secure the gradation reproducibility and stability of driving while optimizing the color temperature of the display color.

**[0010]** In a first aspect of the present invention, a PDP includes a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes, and each pixel of matrix Display has first, second and third cells having different light colors. The effective area of the main electrode of the first cell is different from that of the main electrode of at least the second cell.

**[0011]** In a second aspect of the present invention, a PDP includes a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that is covered by a dielectric layer, and each pixel of matrix display has first, second and third cells having different light colors. The thickness of the dielectric layer of the first cell is different from that of the dielectric layer of at least the second cell.

**[0012]** In a third aspect of the present invention, a PDP includes a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that is covered by a dielectric layer, and each pixel of matrix display has first, second and third cells having different light colors. The relative dielectric constant of the dielectric layer of the first cell is different from that of the dielectric layer of at least the second cell.

**[0013]** In a fourth aspect of the present invention, a PDP includes a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that extend in the same direction, and each pixel of matrix display has

first, second and third cells having different light colors. One pair of the main electrodes is arranged for each row, a dark color layer for enhancing contrast is disposed at each boundary between neighboring rows, and the area of the dark color layer of the first cell is different from that of the dark color layer of at least the second cell. Concerning the first and second cells, the case is included where the area of the dark color layer is zero.

[0014] In a fifth aspect of the present invention, a main electrode includes a transparent conductive film and a banding metal film overlaying the transparent conductive film, and the area of the metal film of the first cell is different from that of the metal film of at least the second cell.

[0015] In a sixth aspect of the present invention, a main electrode includes a transparent conductive film and a banding metal film overlaying the transparent conductive film, and the relative proportion of the metal film to the transparent conductive film of the first cell is different from that of the metal film to the transparent conductive film of at least the second cell.

[0016] In a seventh aspect of the present invention, at least the first cell has a light shield that makes the aperture ratio thereof different from that of the other cell.

[0017] In an eighth aspect of the present invention, a main electrode includes a transparent conductive film and a banding metal film overlaying the transparent conductive film, one pair of the main electrodes is arranged for each row, a dark color layer for enhancing contrast is disposed at each boundary between neighboring rows, the area of the metal film of the first cell is different from that of the metal film of at least the second cell, and the area of the dark color layer of the first cell is different from that of the dark color layer of at least the second cell.

[0018] In a ninth aspect of the present invention, division walls for partitioning the first, second and third cells are provided on a back substrate, and the amount of light shielding for each light color is set by selecting the structure of the light shielding within the range 5 microns away from the top face of the division wall in each of the first, second and third cells.

[0019] The invention may comprise any combination of the features or limitations referred to herein, except a combination in which the features are mutually exclusive.

[0020] Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

[0021] Fig. 1 shows a basic structure of a first embodiment PDP in accordance with the present invention.

[0022] Fig. 2 is a plan view showing the shape of the main electrode.

[0023] Figs. 3A to 8 are plan views showing variations of the shape of the main electrode.

[0024] Fig. 9 is a plan view of a principal portion of a second embodiment PDP in accordance with the present invention.

[0025] Fig. 10 is a cross section of the principal portion of a third embodiment PDP in accordance with the present invention.

[0026] Fig. 11 is a cross section of the principal portion of another embodiment of PDP in accordance with the present invention.

[0027] Fig. 12 is a cross section showing a variation of the dielectric layer.

[0028] Fig. 13 is a cross section of the principal portion of a further embodiment of PDP in accordance with the present invention.

[0029] Fig. 14 is a cross section of the principal portion of another embodiment of PDP in accordance with the present invention.

[0030] Fig. 15 is a cross section of the principal portion of a further embodiment of PDP in accordance with the present invention.

[0031] Fig. 16 is a cross section of the principal portion of another embodiment of PDP in accordance with the present invention.

[0032] Figs. 17A and 17B are plan views of the principal portion of another embodiment of PDP in accordance with the present invention.

[0033] Fig. 1 shows a basic structure of a first PDP in accordance with the present invention.

[0034] The illustrated PDP 1 is an AC type color PDP with a surface discharging configuration having a pair of substrate structures 10, 20. In each cell making up a screen ES, a pair of banding main electrodes X and Y and an address electrode A cross each other. The main electrodes X and Y are arranged on the inner side of a glass substrate 11 that is a front substrate structure 10. Each of the main electrodes X and Y includes a transparent conductive film 41 and a metal film (a bus electrode) 42 for securing conductivity. The metal film 42 is made up of three layers such as chromium, copper and chromium, which are laminated in the middle portion in the column direction of the transparent conductive film 41. Covering the main electrodes X and Y, a dielectric layer 17 is provided, which has thickness of 30-50 microns. The surface of the dielectric layer 17 is coated with magnesia (MgO) that is a protection film 18.

[0035] The address electrodes A are arranged on the inner surface of a glass substrate 21 that is a substrate of the back substrate structure 20, and covered with a dielectric layer 24. On the dielectric layer 24, one division wall 29 having height of 100-200 microns (typically 150 microns) is disposed at each gap between the address electrodes A. The division walls 29 partition a discharging space 30 in the row direction (the horizontal direction in the screen) for each column, and define the gap size of the discharging space 30. Furthermore, three color (R, G and B) fluorescent layers 28R, 28G and 28B for color display are provided so as to cover the back inner surface including the upper portion of the address electrode A and the side of the division wall 29. Discharging gas that is a mixture of neon as a main gas and xenon is filled in the discharging space 30, and the

fluorescent layers 28R, 28G and 28B emit light being exited partially by ultraviolet rays radiated by the xenon gas. One pixel of the display includes three subpixels (units of light emitting area) arranged in the row direction. A structure in each subpixel is a cell (display element) C. Since the arrangement pattern of the division walls 29 is a stripe pattern, the portion of the discharging space 30 corresponding to each column (a column space) is continuous over the all rows. Therefore, uniform fluorescent layers 28R, 28G and 28B having little bubbles can be formed by screen printing that is suitable for mass production. Here, a row is a set of cells having the same position in the column direction.

**[0036]** Hereinafter, an example of configuration for relatively enhancing the luminous intensity of the blue (B) fluorescent layer 28B is explained. However, the color to be enhanced is not limited to the blue. The similar effect can be obtained if the color is red (R) or green (G). In addition, it is possible to enhance plural colors, as well as to change ratio of enhancing the colors. In the attached figures, the main electrodes and the cells are accompanied with the same reference numerals despite different configurations.

**[0037]** Fig. 2 is a plan view showing the shape of the main electrode.

**[0038]** Each of the main electrodes X and Y include the transparent conductive film 41 and the metal film 42 as explained above. Since the metal film 42 is completely overlapped with the transparent conductive film 41 within the screen, the shape of the transparent conductive film 41 viewed from above is also that of the main electrode X or Y. The main electrodes X and Y are arranged substantially in a constant pitch. The main electrodes X and Y except both ends of the arrangement are used for both displays of odd and even rows. The main electrodes X and Y of the both ends are used for a display of odd or even row. The structure of rectangular area defined by the division walls 29 and the metal films 42 is the cell C. The gap between the main electrodes in each cell C is the surface discharging gap.

**[0039]** In the example of Fig. 2, the width of the main electrodes X and Y (i.e., the width of the transparent conductive film 41) is not constant, but is partially wide so that the interelectrode gap d2 in the cell C of the blue (B) light color is smaller than the interelectrode gap d1 in the other cells. Thus, the effective area of the main electrode related to the sustaining is larger in the cell C of the blue light color than in the other cells. Therefore, the discharge having large current density occurs in the cell C, so that the luminous intensity increases. Since the main electrodes X and Y are formed by lithography, high accuracy patterning is possible.

**[0040]** Figs. 3A to 8 are plan views showing variations of the shape of the main electrode.

**[0041]** In the example of Fig. 3A, each of the main electrodes X and Y includes a banding metal film 42 and transparent conductive film 43 or 44 that has a rectangular shape and is disposed for each cell. In the cell C

of blue light color, the length in the row direction of the transparent conductive film 44 is set longer than the transparent conductive film 43 of the other two colors, so that the effective area of the main electrode is enlarged.

**[0042]** In the example of Fig. 3B, each of the main electrodes X and Y includes a banding metal film 42 and a strip transparent conductive film 45 that is long in the column direction. In the cell C of blue light color, the transparent conductive films 45 are disposed more than in other two colors, so that the effective area of the main electrode is enlarged.

**[0043]** In the example of Fig. 3C, each of the main electrodes X and Y includes a banding metal film 42 and strip transparent conductive films 45 and 46 that are long in the column direction. In the cell C of blue light color, the wider transparent conductive film 46 is disposed compared with other two colors, so that the effective area of the main electrode is enlarged.

**[0044]** In the example of Fig. 4A, each of the main electrodes X and Y includes a banding metal film 42 and a ladder-like transparent conductive film 47. The transparent conductive film 47 has two banding portions 47A extending in parallel in the row direction and banding portions 47Ba and 47Bb extending in the column direction in each column so as to link the banding portions 47A. In the cell C of blue light color, the width of the banding portion 47Bb corresponding thereto is set wider than the banding portion 47Ba corresponding to the cells C of the other two colors, so that the effective area of the main electrode is enlarged.

**[0045]** In the example of Fig. 4B, each of the main electrodes X and Y includes a banding metal film 42 and a ladder-like transparent conductive film 48. The transparent conductive film 48 has two banding portions 48A extending in parallel in the row direction and banding portion 48B extending in the column direction in each column so as to link the banding portions 48A. In the cell C of blue light color, the width of the banding portion 48A is partially enlarged, so that the effective area of the main electrode is enlarged.

**[0046]** In the example of Fig. 4C, each of the main electrodes X and Y includes a banding metal film 42 and a banding transparent conductive film 49 having a hole 50. By arranging the hole in the cells C of the red light color and the green light color, the effective area of the main electrode in blue light color is relatively enlarged.

**[0047]** In the example of Fig. 5A, each of the main electrodes X and Y includes a banding metal film 42 and substantially I-shaped transparent conductive films 52 and 53. Since the main electrodes X and Y straddle two rows, the portion corresponding to one cell in the transparent conductive films 52 and 53 is substantially T-shaped. Concerning the cell C of blue light color, the portion 53B of the transparent conductive film 53 extending in the column direction is wider than the portion extending in the column direction of the transparent conductive film 52 corresponding to the other cells C, so

that the effective area of the main electrode is enlarged.

[0048] In the example of Fig. 5B, each of the main electrodes X and Y includes a banding metal film 42 and substantially I-shaped transparent conductive films 54 and 55. Since the main electrodes X and Y straddle two rows, the portion corresponding to one cell in the transparent conductive films 54 and 55 is substantially T-shaped. Concerning the cell C of blue light color, the portion 55A of the transparent conductive film 54 extending in the row direction is wider than the portion extending in the row direction of the transparent conductive film 54 corresponding to the other cells C, so that the effective area of the main electrode is enlarged.

[0049] Both main electrodes X and Y do not always need the enlargement of the electrode area. The enlargement of the electrode area can be realized for either main electrode X or Y. This is true for any example of Figs. 2-5. If each of the main electrodes X and Y is cut partially in the column direction as shown in Figs. 4A, 4B and 5, the surface discharge can be localized in the vicinity of the surface discharging gap, so that the resolution can be enhanced. If each of the main electrodes X and Y is shaped such that the main electrode gap is wider than the surface discharging gap periodically along the row direction as shown in Figs. 3 and 5, the capacitance between the electrodes becomes smaller than that in the case where the main electrode gap is constant over the entire length in the row direction, thereby the driving characteristics are improved. In addition, the electrode area becomes small so that the discharge current decreases. Therefore, the requirement for the current capacity to the driving circuit about the current capacity is relieved. Decrease of the intensity due to the decrease of the discharge current can be compensated by increasing the drive frequency.

[0050] The arrangements of the main electrode in the above-mentioned examples are constant pitch arrangements suitable for an interlace format display such as a television set. However, the present invention is not limited thereto. An example of the present invention applied to the electrode arrangement in which a pair of the main electrodes X and Y is arranged for each row will be explained below.

[0051] In the constant pitch arrangement, the metal film 42 is disposed at the middle in the width direction of the transparent conductive film 41 so that the cell structure of all rows can be uniform. On the contrary, if a pair of main electrodes X and Y is arranged for each row, the metal film 42 can be disposed at the surface discharging gap side or the opposite side thereof.

[0052] In the example of Fig. 6, the effective area of the main electrode is enlarged in the cell C of the blue light color by partially widening the transparent conductive film 42 so that the surface discharging gap is narrowed in the same way as in the example of Fig. 2.

[0053] In the example of Fig. 7, the metal film 42 that makes up the main electrode X is disposed at the surface discharging gap side. The transparent conductive

film 41 of the main electrode X is partially widened so as to protrude in the direction opposite to the surface discharging gap. Thus, the effective area of the main electrode in the cell C of the blue light color is enlarged.

[0054] In the example of Fig. 8, the metal film 42 of each of the main electrodes X and Y is disposed at the surface discharging gap side. The transparent conductive film 41 of the main electrodes X and Y is partially widened so as to protrude in the direction opposite to the surface discharging gap. Thus, the effective area of the main electrode in the cell C of the blue light color is enlarged. The shape of the transparent conductive film in the examples of Figs. 2-5 can be applied to the examples of Figs. 6-8 also.

[0055] Fig. 9 is a plan view of a principal portion of a second PDP in accordance with the present invention.

[0056] The PDP 2 also is a reflection type similar to the PDP 1 shown in Fig. 1. The main electrodes X and Y include a transparent conductive film 61 and a metal film 62. The main electrodes X and Y are arranged in inconstant pitch in the same manner as in Figs. 6-8, in which the interelectrode gap (referred to as an inverse slit) between rows is set to a value sufficiently larger than the surface discharging gap so as to prevent interference with discharge. Both the transparent conductive film 61 and the metal film 62 have a banding shape with a constant width, so that the effective area of the main electrodes X and Y is uniform for all cells C.

[0057] In the PDP 2, in order to enhance the contrast, a paint is applied to the outer surface of the glass substrate 11 of the front side (see Fig. 11), or a colored glass layer is formed on the inner surface of the glass substrate 11, so that a banding dark color layer 65 is arranged on the inverse slit. Namely, so-called black stripe is formed so that a pale color of the fluorescent layer 28 on the back glass substrate 21 cannot be seen through the inverse slit. The width of the dark color layer 65 is partially narrowed in the column of blue light color. Thus, the light shield by the dark color layer 65 is relieved in the cells C of blue light color, and the intensity therein is increased compared with other cells C.

[0058] Fig. 10 is a cross section of the principal portion of a third PDP in accordance with the present invention.

[0059] The PDP 3 of this example is also a surface discharge and reflection type. The inner surface of the front glass substrate 411 is provided with main electrodes X and Y (only main electrode X is illustrated) and a dielectric layer 417. The address electrodes A and the division walls 29 are arranged on the back glass substrate 421, and fluorescent layers 428R, 428G and 428B are formed between the division walls. In the PDP 3, the dielectric layer 417 is thin at the portion corresponding to the cells of blue light color compared with cells of other colors. Therefore, the intensity of electric field is increased in the cells of blue light color so that the discharge is enhanced for high light intensity.

[0060] Fig. 11 is a cross section of the principal portion of a fourth PDP in accordance with the present inven-

tion. In Fig. 11, the element corresponding to that in Fig. 10 is denoted by the same reference numeral.

**[0061]** In the PDP 4 of this example too, the inner surface of the front glass substrate 411 is provided with main electrodes X and Y (only main electrode X is illustrated) and a dielectric layer 419. The address electrodes A and the division walls 29 are arranged on the back glass substrate 421, and fluorescent layers 428R, 428G and 428B are formed between the division walls. In the PDP 4, the portion of the dielectric layer 417 corresponding to the cells of blue light color has an embedded layer 419a whose relative dielectric constant is larger than other portions.

**[0062]** Thus, the discharge current increases to enhance the discharge in the cell of blue light color, so that the light intensity increases. For example, the dielectric layer 419 can be formed by printing the material of the layer 419a in the pattern, printing the material of other portion flatly, and baking.

**[0063]** Fig. 12 is a cross section showing a variation of the dielectric layer.

**[0064]** In the PDP 4b of Fig. 12, a first dielectric layer 419B is provided to the cells of red or green light colors, while a second dielectric layer 419Ba is provided to the cells of blue light color. The relative dielectric constant of the dielectric layer 419Ba is larger than that of the dielectric layer 419B. The dielectric layers 419B and 419Ba are formed by printing each material in the pattern and baking.

**[0065]** There are other methods for adjusting the relative light intensity. One is to change the distance between the fluorescent layer and the main electrode in accordance with the color. Another is to color the division wall 29 and the back dielectric layer 24, and to change the color or the tone. These methods can be used in conjunction with each of the above-mentioned examples.

**[0066]** Fig. 13 is a cross section of the principal portion of a fifth PDP in accordance with the present invention.

**[0067]** The PDP 5 is a reflection type in which the main electrodes X and Y for surface discharge are arranged in the constant pitch in the same way as in Fig. 1. Each of the main electrodes X and Y includes a transparent conductive film 41b having a constant width and a metal film 42b overlayed thereon at the middle of the width. In the PDP 5, the utilization ratio of visible light for the cell C is adjusted by changing the width of the metal film 42b for each light color (R, G or B). The width of the cell whose relative intensity is to increase (the cell of blue color if the color temperature should be improved) is narrowed compared with other portion. On the contrary, the width of the cell whose relative intensity is not to increase (the cell of blue color) is widened. Thus, the relative intensity can be adjusted without changing the line resistance of the bus conductor. There is no problem even if the value of the metal film 42b in each cell is different between the main electrode X and the main electrode Y. The firing potential that is important for con-

trolling the discharge is mainly determined by the transparent conductive film 41b, so it cannot be any obstacle to the discharge control. For example, the width  $W_t$  of the transparent conductive film 41b is set to 275 microns, the arrangement pitch  $R_p$  of the division wall 29 is set to 360 microns, the width  $W_{b1}$  of the metal film 42b of the red color cell is set to 140 microns, the width  $W_{b2}$  of the metal film 42b of the green color cell is set to 100 microns, and the width  $W_{b3}$  of the metal film 42b of the blue color cell is set to 60 microns, so that the intensity of the blue color cell whose aperture ratio is increased increases by 11%, while the intensity of the red color cell whose aperture ratio is decreased decreases by 20%. In addition, if there is a difference of structure between the cells arranged in the row direction as shown in this example, there is a possibility that desired characteristics cannot be obtained when a position shift occurs between the front substrate and the back substrate. In order to prevent this occurrence, the distance  $p$  between the portion of the metal film 42b whose width increases or decreases and the center of the upper face of the division wall 29 can be set to a value more than 5 microns and less than one third of the arrangement pitch  $R_p$ , so that a predetermined performance can be obtained by a practical accuracy of positioning.

**[0068]** Fig. 14 is a cross section of the principal portion of a sixth PDP in accordance with the present invention.

**[0069]** In the PDP 6, the relative intensities of red, green and blue colors can be adjusted by selecting the position of the metal film 42c on the transparent conductive film 41b. In this configuration too, the problem of the firing potential cannot occur in the same way as in Fig. 13.

**[0070]** Fig. 15 is a cross section of the principal portion of a seventh PDP in accordance with the present invention.

**[0071]** The PDP 7 is a reflection type in which the main electrodes X and Y for surface discharge are arranged in inconstant pitch, and include a dark color layer 65b for light shield of the inverse slit in the same manner as in Fig. 9. In the PDP 7, the utilization ratio of visible light for the cell C is adjusted by changing the width of the metal film 62b and the width of the dark color layer 65b for each light color (R, G or B). If the width of the dark color layer 65b is decreased from 350 microns to 175 microns, the intensity can be increased by approximately 11%. The adjustment of the relative intensities by setting the width of the dark color layer 65b that does not have electric function has more flexibility than the adjustment by the metal film.

**[0072]** Fig. 16 is a cross section of the principal portion of an eighth PDP in accordance with the present invention.

**[0073]** In the PDP 8, the position of the metal film 62c on the transparent conductive film 61 is selected for adjusting the relative intensity of red, green and blue colors. In this configuration too, the problem of the firing potential cannot occur in the same way as in Fig. 13. In

the examples of Fig. 16 as well as the example of Fig. 15, the shapes of the electrodes of the main electrode X and the main electrode Y can be asymmetric.

[0074] Figs. 17A and 17B are plan views of the principal portion of a ninth PDP in accordance with the present invention.

[0075] In the PDP 9a shown in Fig. 17A, adding to the dark color layer 65d of the inverse slit, the cells of red color and green color are provided with light shielding films 71 and 72 for adjusting the aperture ratio, which are disposed at the dark color layer 65d side. In the PDP 9b shown in Fig. 17B, light shielding films 73 and 74 are disposed within the area of the surface discharging gap. The adjustment of the relative intensities by the light shielding films 71-74 has an advantage in that the adjustment range is wide since any shielding area can be selected.

[0076] According to the above-mentioned embodiments, the shape of the main electrodes X and Y formed by the photolithography process with high accuracy, the thickness of the dielectric layer that can be controlled relatively easily, or the relative dielectric constant can adjust the discharge intensity or the utilization ratio of visible light for each color independently, so that the adjustment of the light intensity can be performed with high reproducibility and high accuracy. As a result, intensity of blue light that is a weak point of PDPs can be securely increased, so that the color reproducible range can be enlarged and the color temperature of the white color display can be raised.

[0077] The present invention is not limited to a reflection type surface discharge format, but can be applied to a transparent type surface discharge format or an opposed discharging format PDP too.

[0078] According to the present invention, the color temperature of the displayed color can be optimized while the gradation reproducibility and the stability of driving are secured.

## Claims

1. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes, and each pixel of matrix display has first, second and third cells having different light colors, wherein

the effective area of the main electrode of the first cell is different from the effective area of the main electrode of at least the second cell.

2. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that is covered by a dielectric layer, and each pixel of matrix display has first, second and third cells having different light colors,

wherein

the thickness of the dielectric layer of the first cell is different from the thickness of the dielectric layer of at least the second cell.

3. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that is covered by a dielectric layer, and each pixel of matrix display has first, second and third cells having different light colors, wherein

the relative dielectric constant of the dielectric layer of the first cell is different from the relative dielectric constant of the dielectric layer of at least the second cell.

4. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that extend in the same direction, and each pixel of matrix display has first, second and third cells having different light colors, wherein

one pair of the main electrodes is arranged for each row,  
a dark color layer for enhancing contrast is disposed at each boundary between neighboring rows, and  
the area of the dark color layer of the first cell is different from the area of the dark color layer of at least the second cell.

5. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that extend in the same direction, and each pixel of matrix display has first, second and third cells having different light colors, wherein

the main electrode includes a transparent conductive film and a banding metal film overlaying the transparent conductive film, and  
the area of the metal film of the first cell is different from the area of the metal film of at least the second cell.

6. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that extend in the same direction, and each pixel of matrix display has first, second and third cells having different light colors, wherein

the main electrode includes a transparent con-



ductive film and a banding metal film overlaying the transparent conductive film, and the relative proportion of the metal film to the transparent conductive film of the first cell is different from the relative proportion of the metal film to the transparent conductive film of at least the second cell. 5

7. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that extend in the same direction, and each pixel of matrix display has first, second and third cells having different light colors, wherein 10 15

at least the first cell has a light shield that makes the aperture ratio thereof different from the aperture ratio of the other cell.

8. A plasma display panel comprising a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes that extend in the same direction, and each pixel of matrix display has first, second and third cells having different light colors, wherein 20 25

the main electrode includes a transparent conductive film and a banding metal film overlaying the transparent conductive film, 30 one pair of the main electrodes is arranged for each row, a dark color layer for enhancing contrast is disposed at each boundary between neighboring rows, 35 the area of the metal film of the first cell is different from the area of the metal film of at least the second cell, and the area of the dark color layer of the first cell is different from the area of the dark color layer of at least the second cell. 40

9. The plasma display panel according to any one of claims 5 to 8, wherein 45

division walls for partitioning the first, second and third cells is provided on a back substrate, and the amount of light shielding for each light color is set by selecting the structure of the light shielding within the range 5 microns away from the top face of the division wall in each of the first, second and third cells. 50 55



Fig. 1

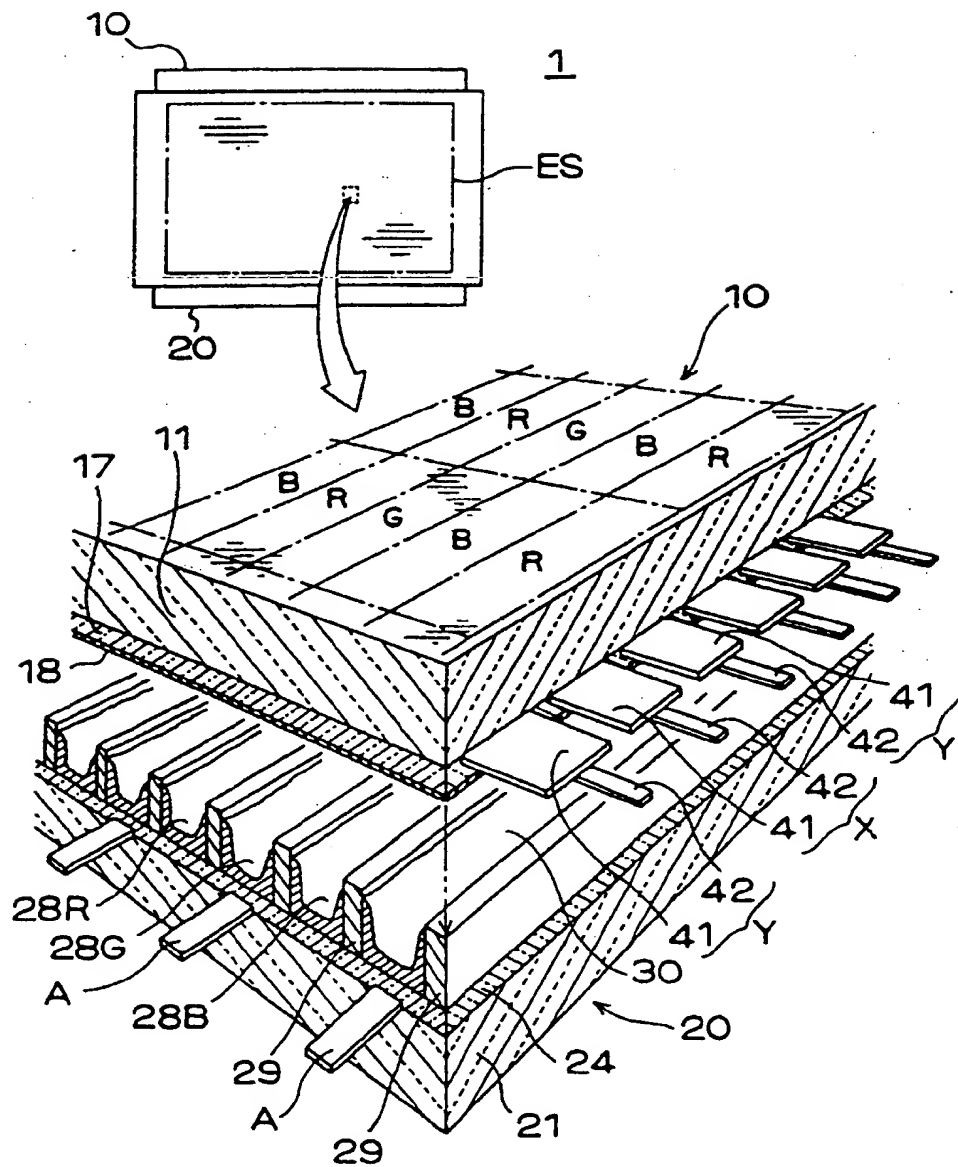


Fig. 2

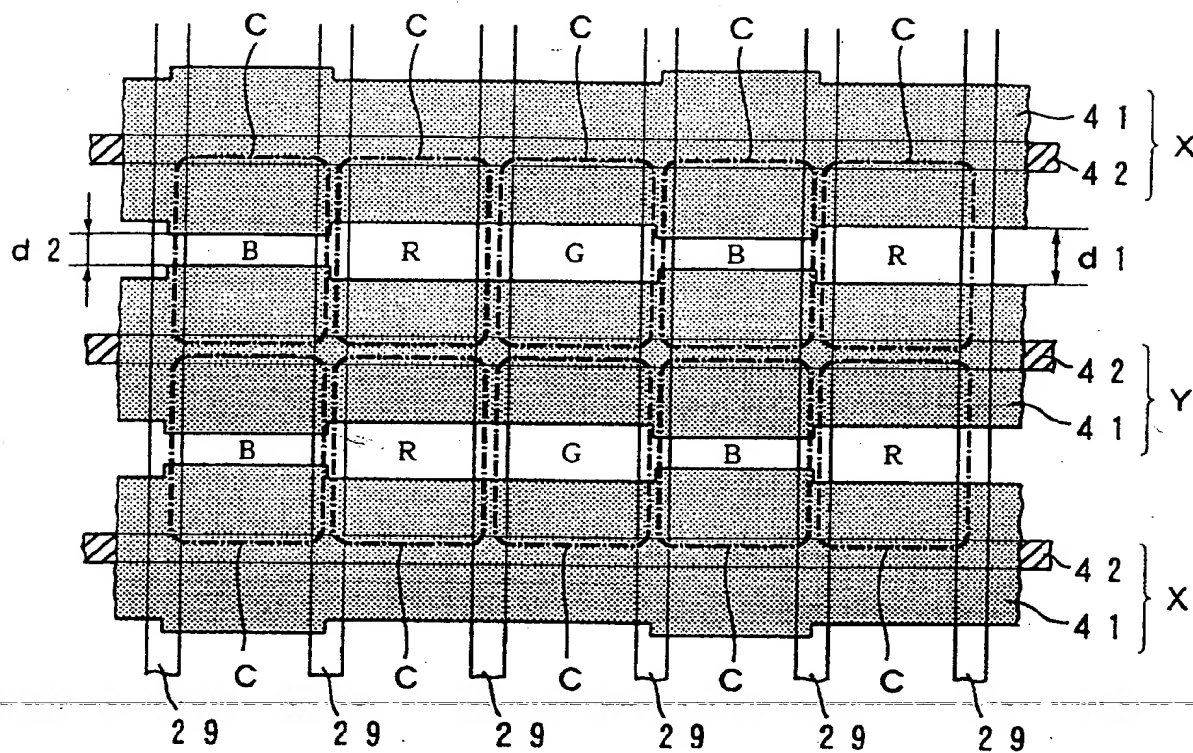


Fig. 3A

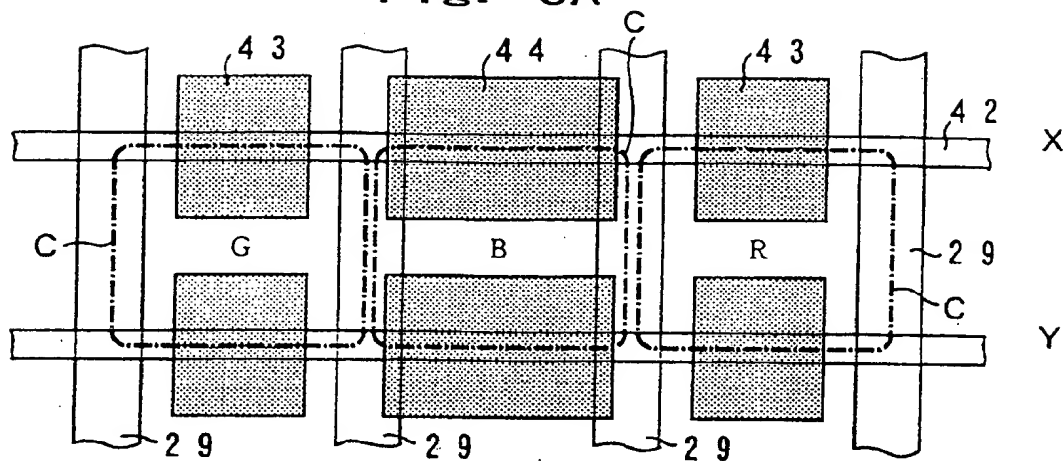


Fig. 3B

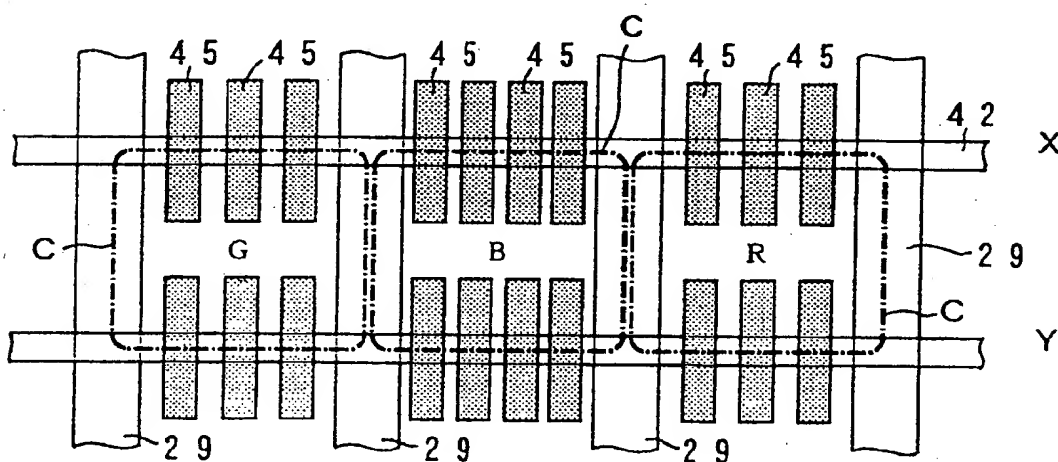


Fig. 3C

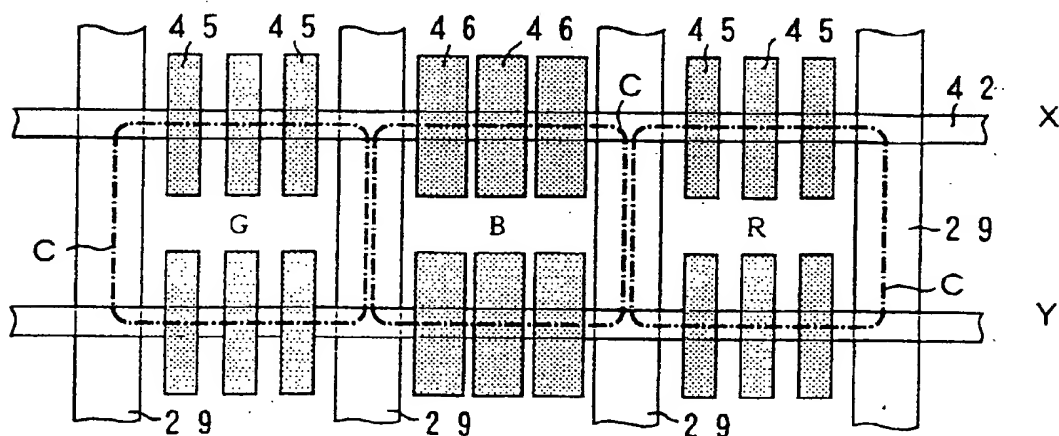


Fig. 4A

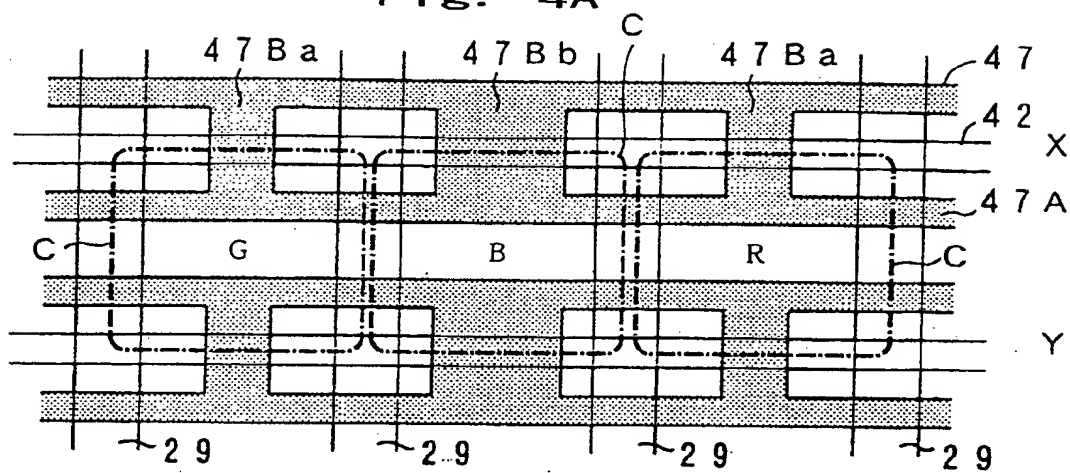


Fig. 4B

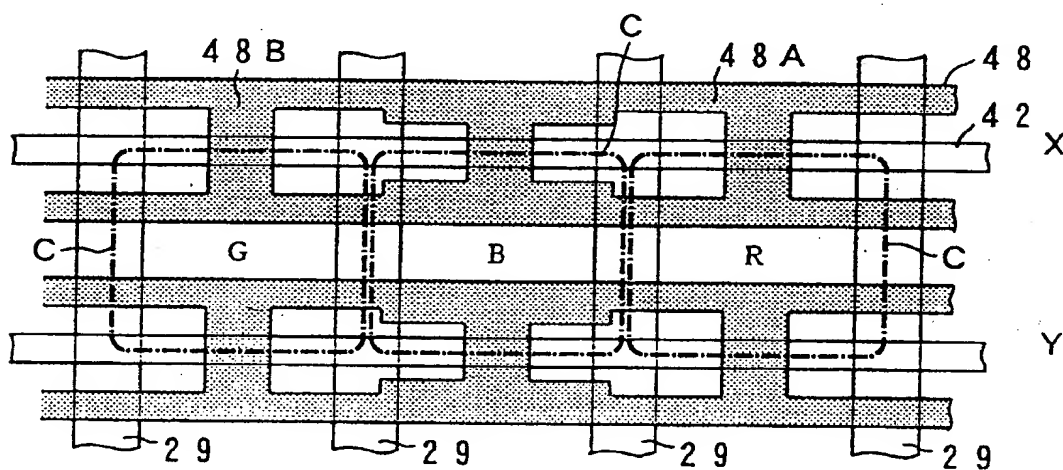
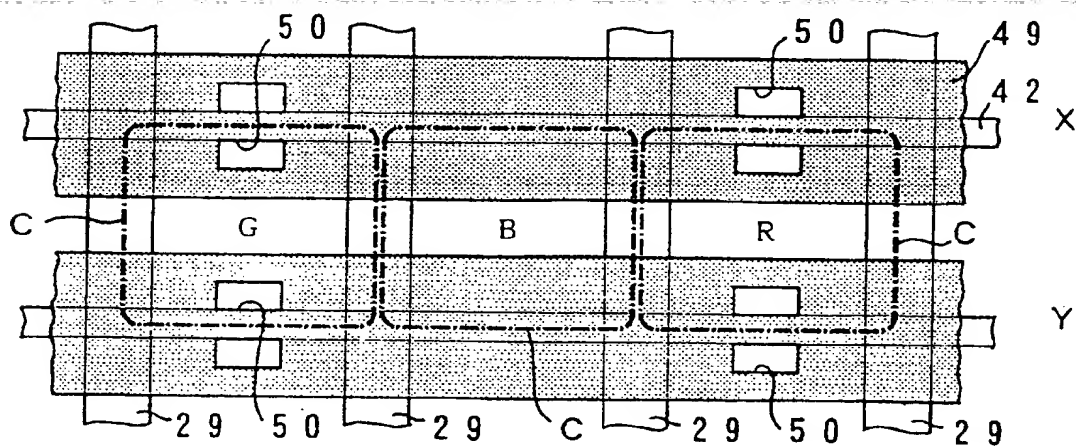
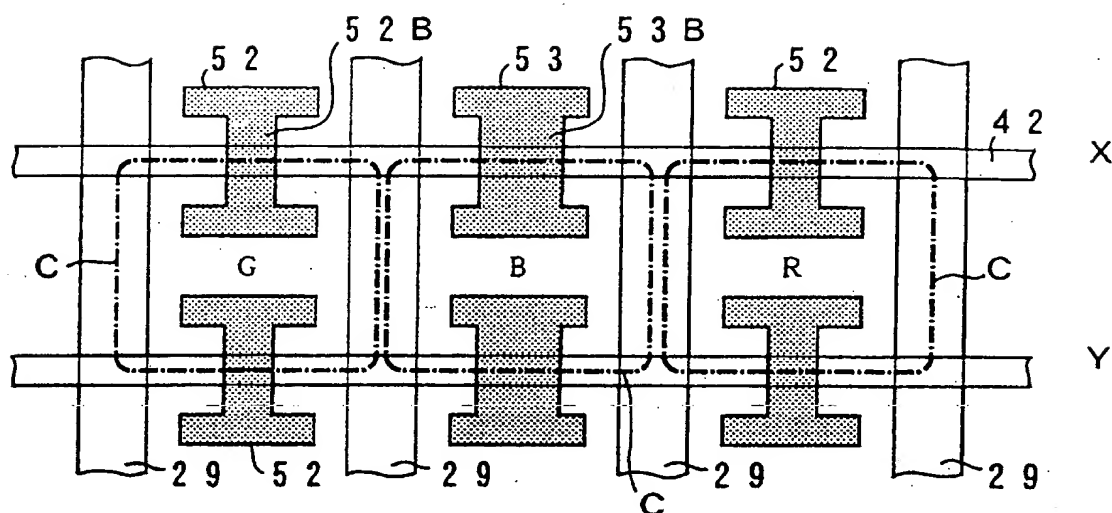


Fig. 4C



**Fig. 5A**



**Fig. 5B**

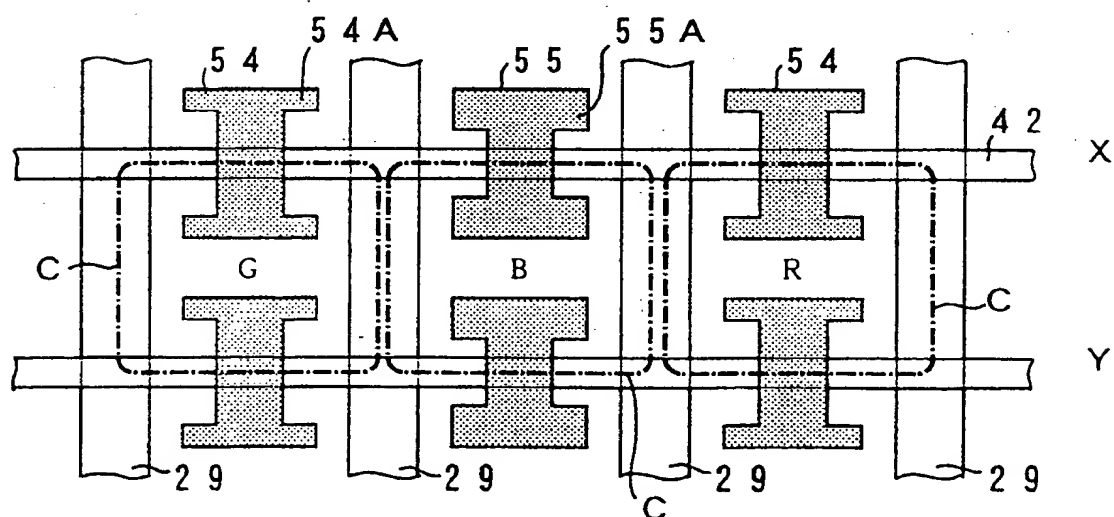


Fig. 6

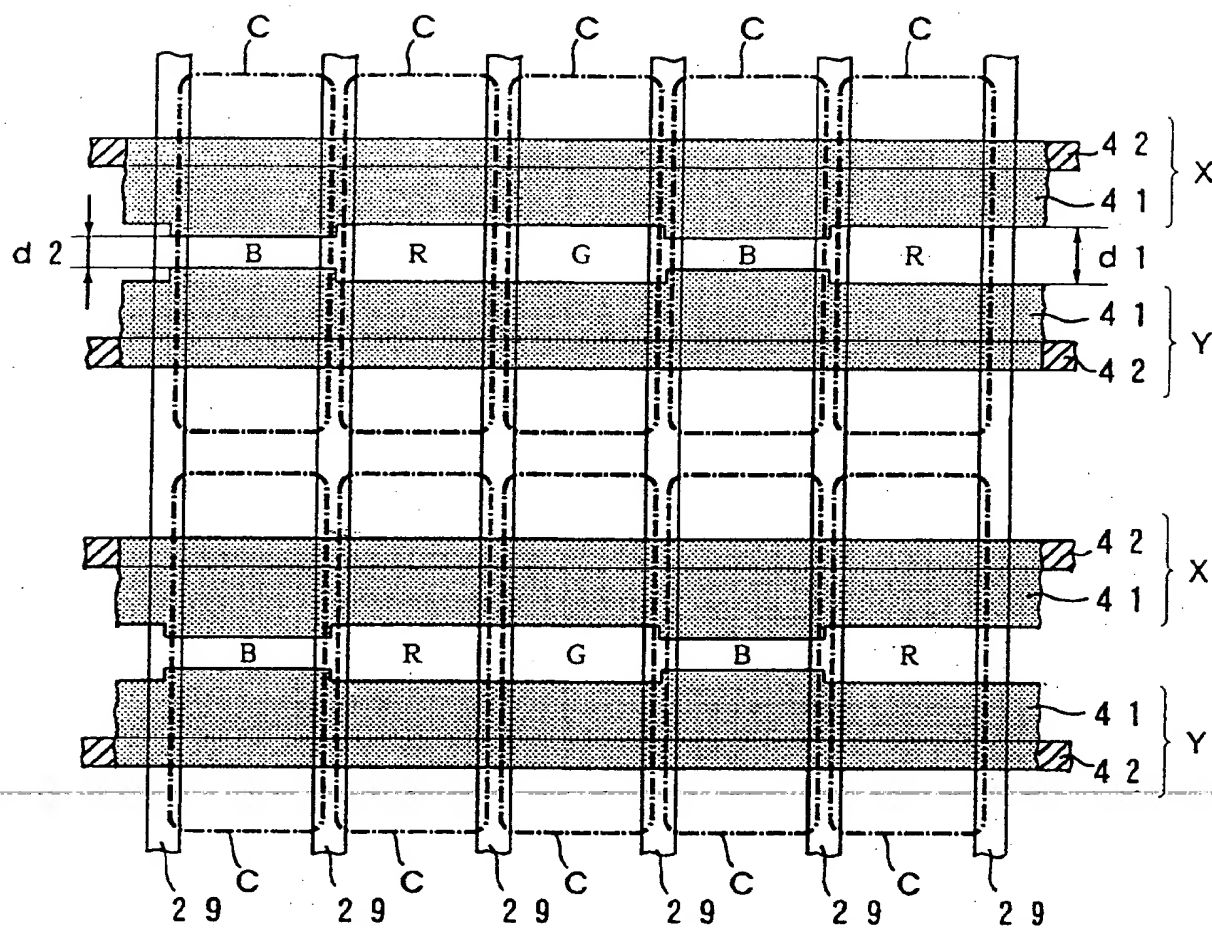


Fig. 7

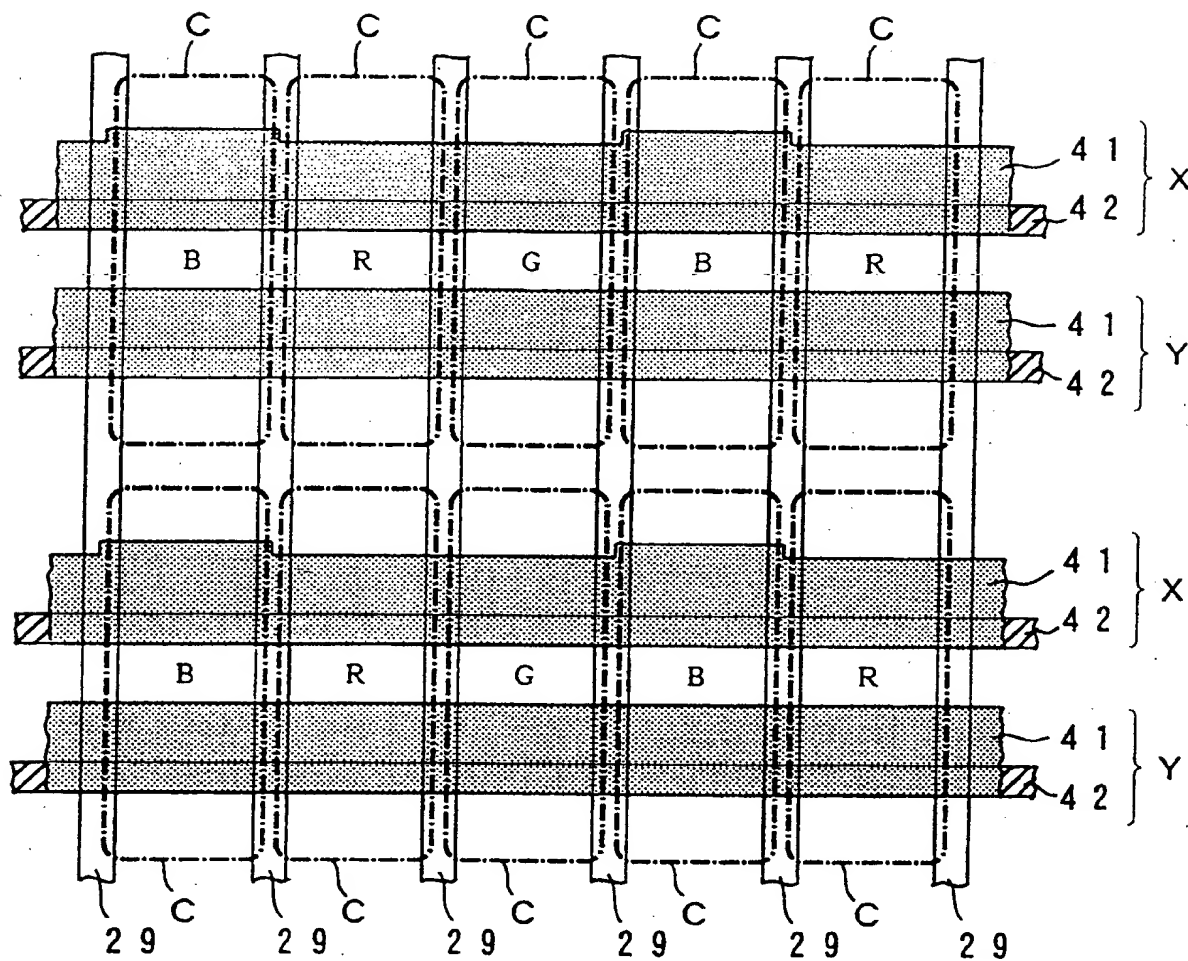




Fig. 8

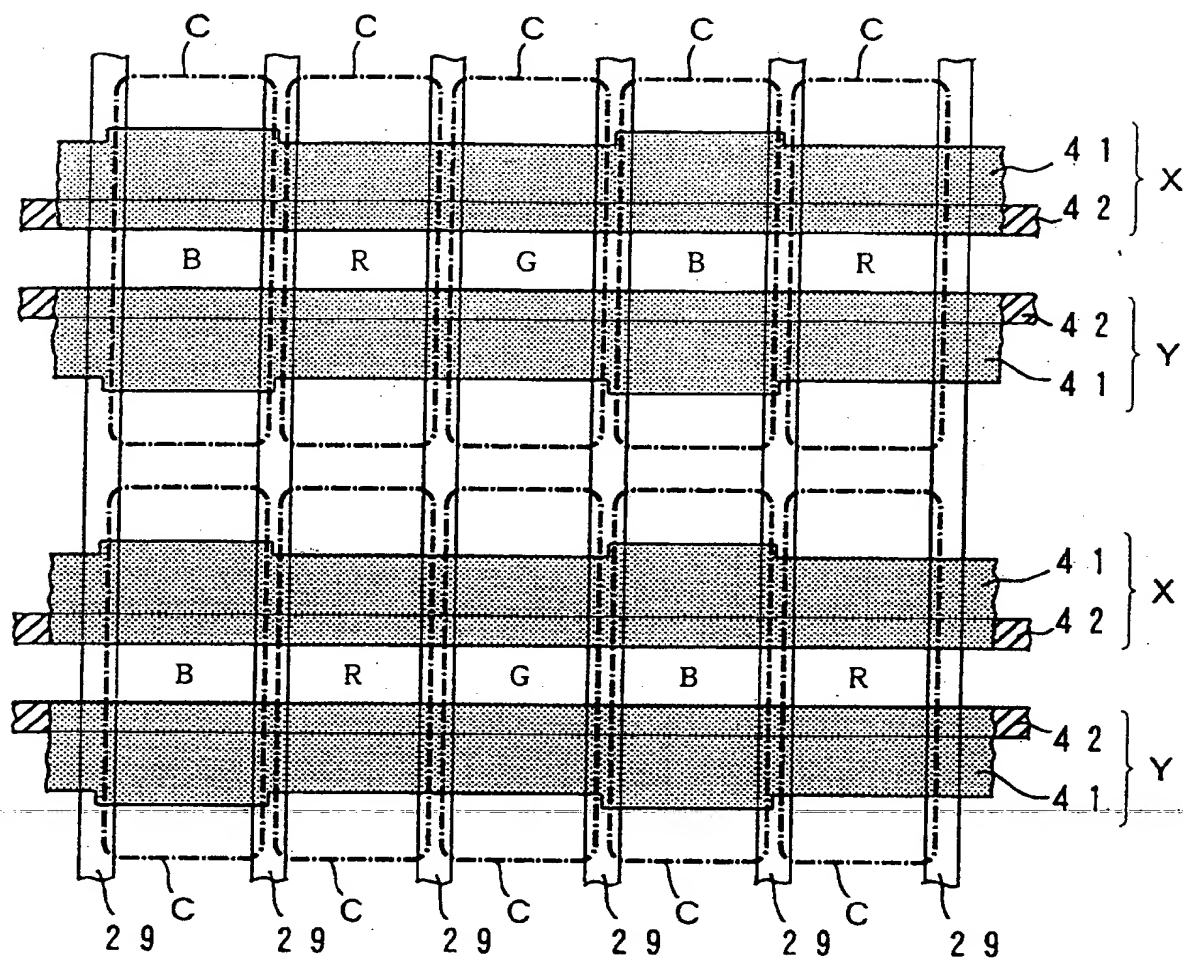


Fig. 9

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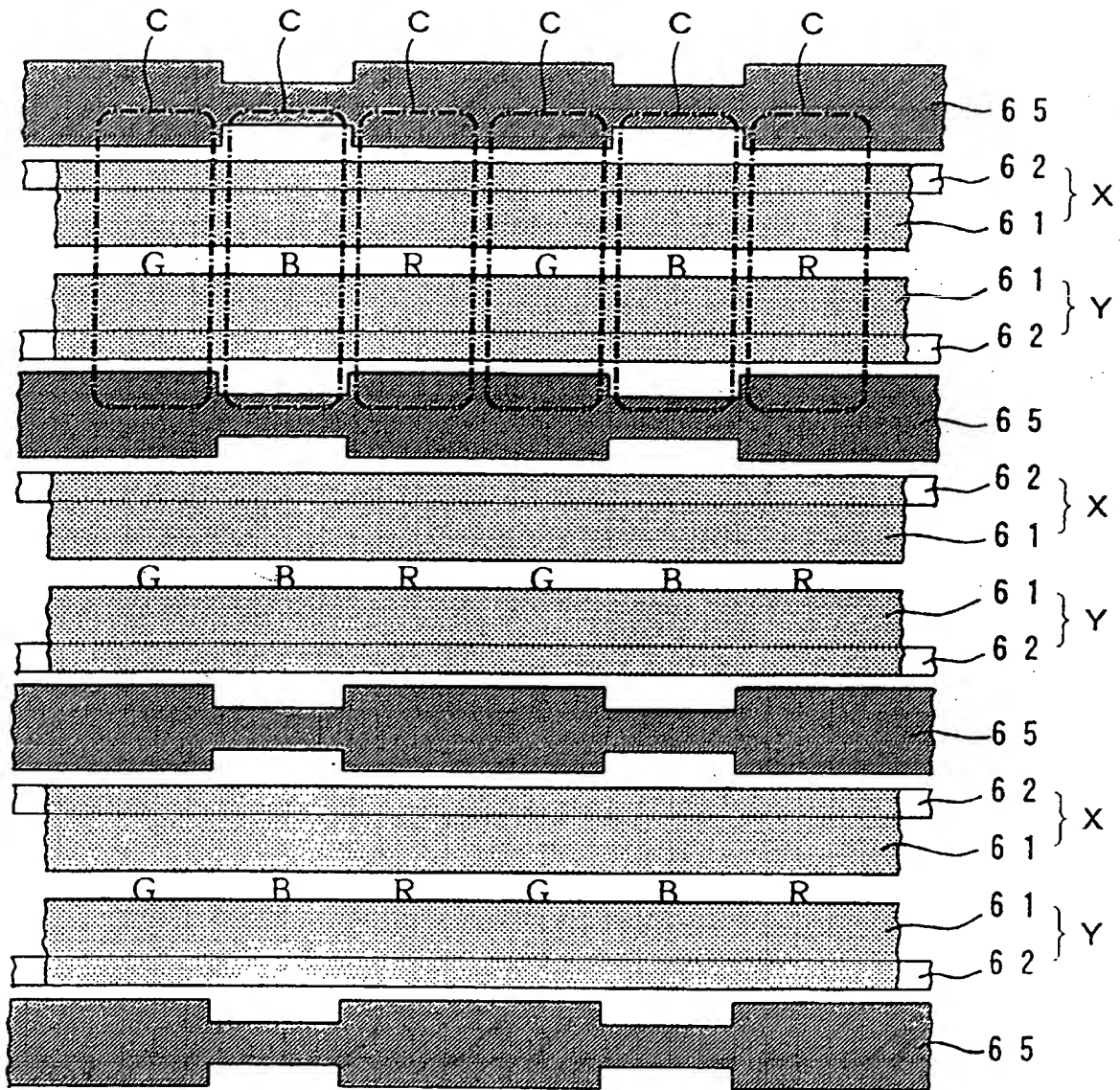


Fig. 10

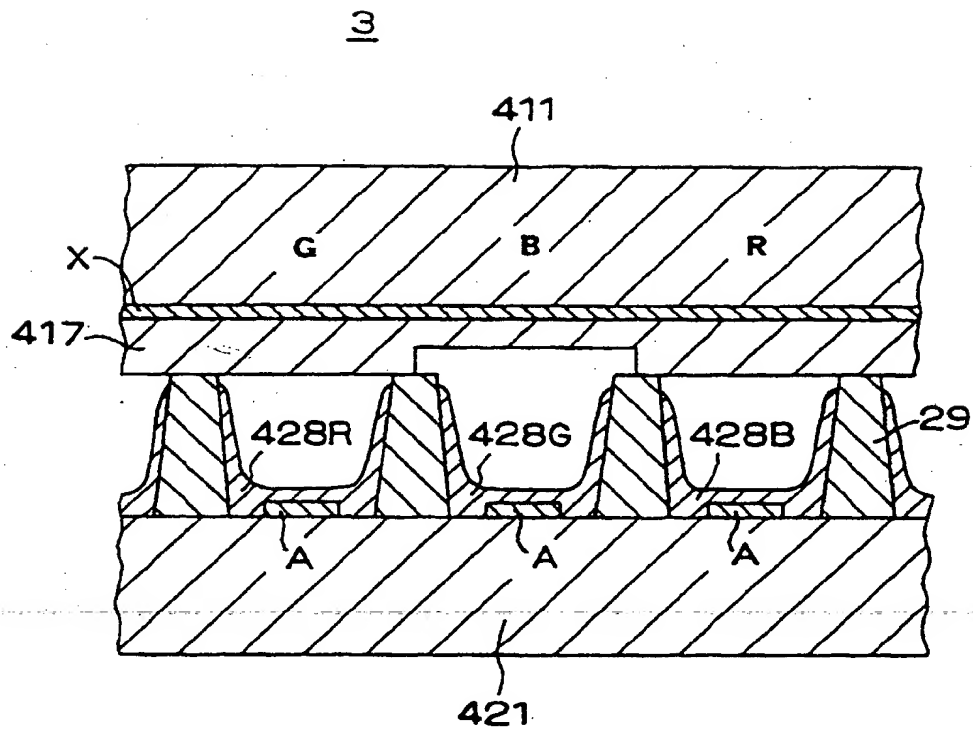


Fig. 11

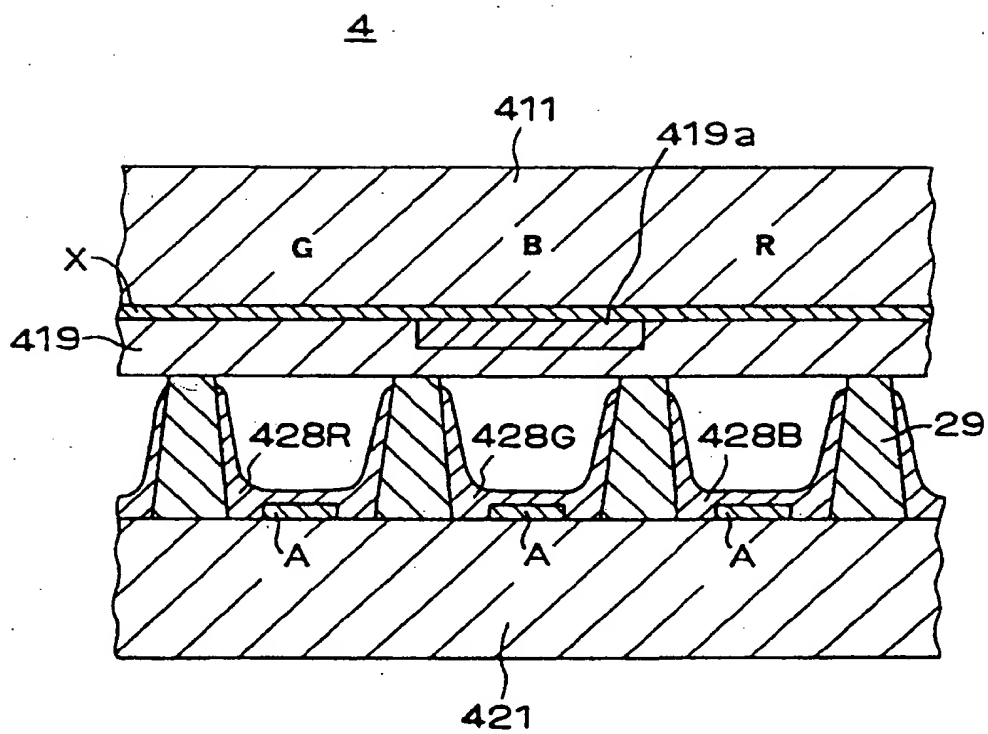


Fig. 12

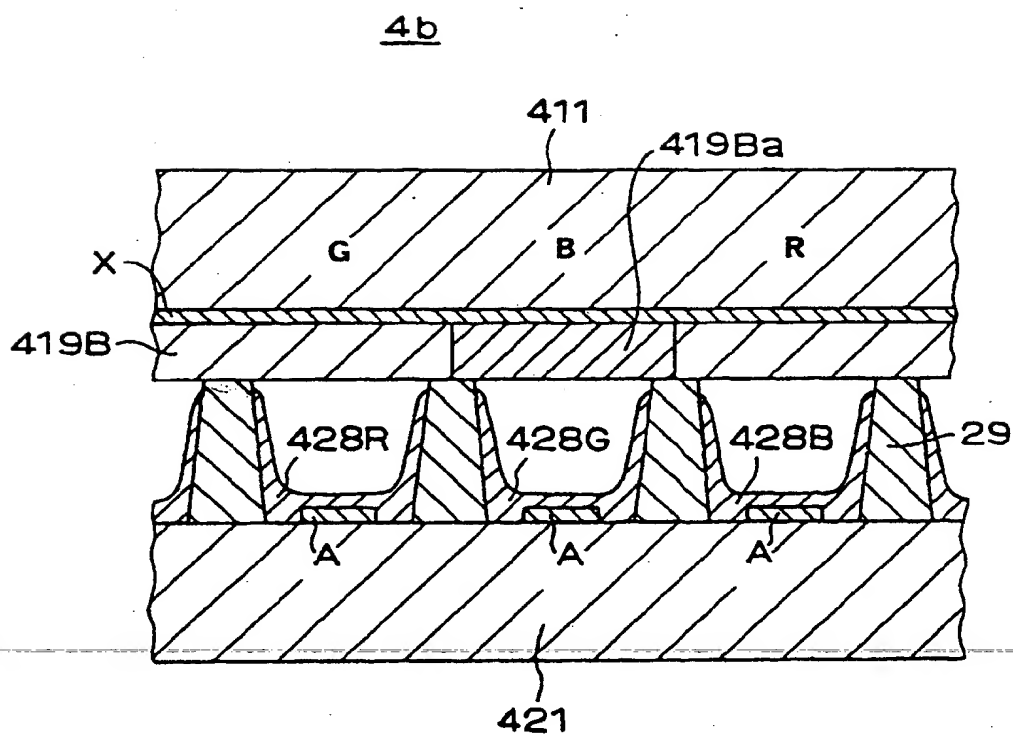


Fig. 13

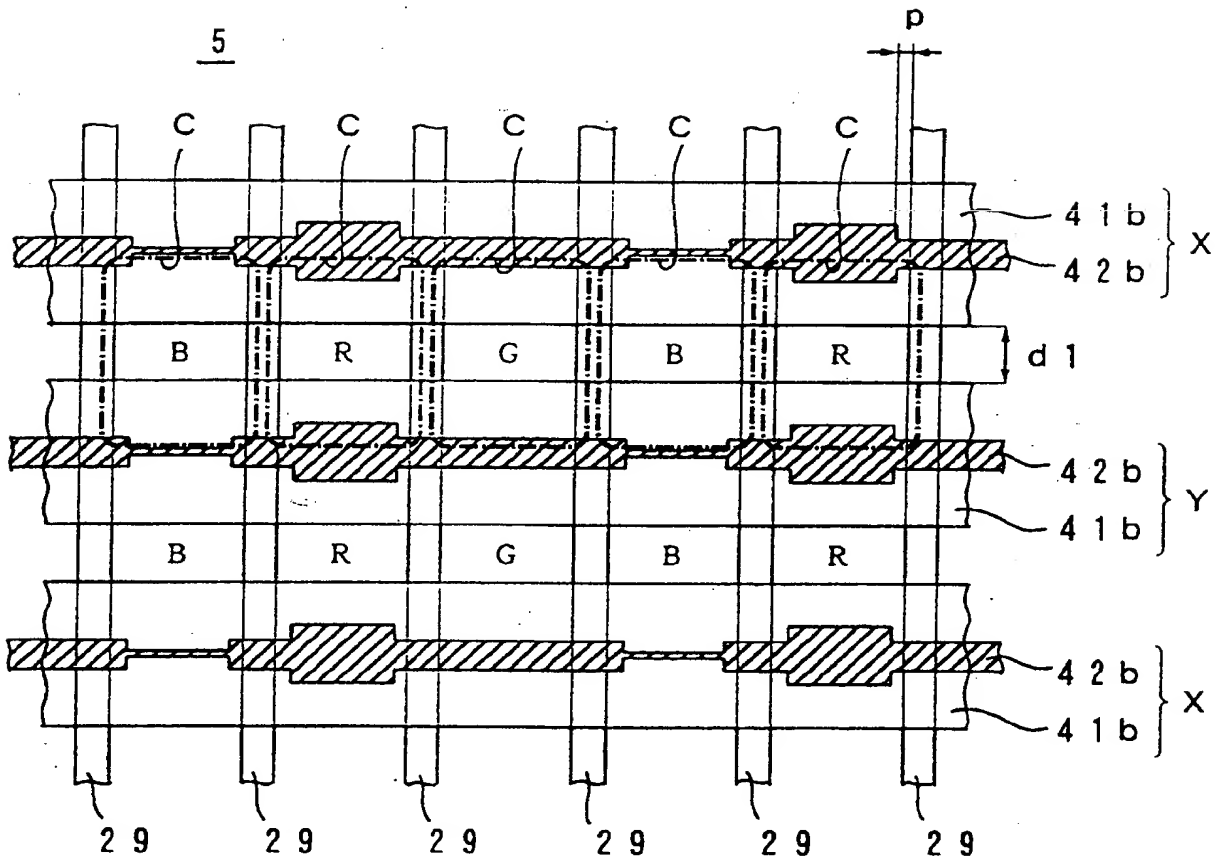


Fig. 14

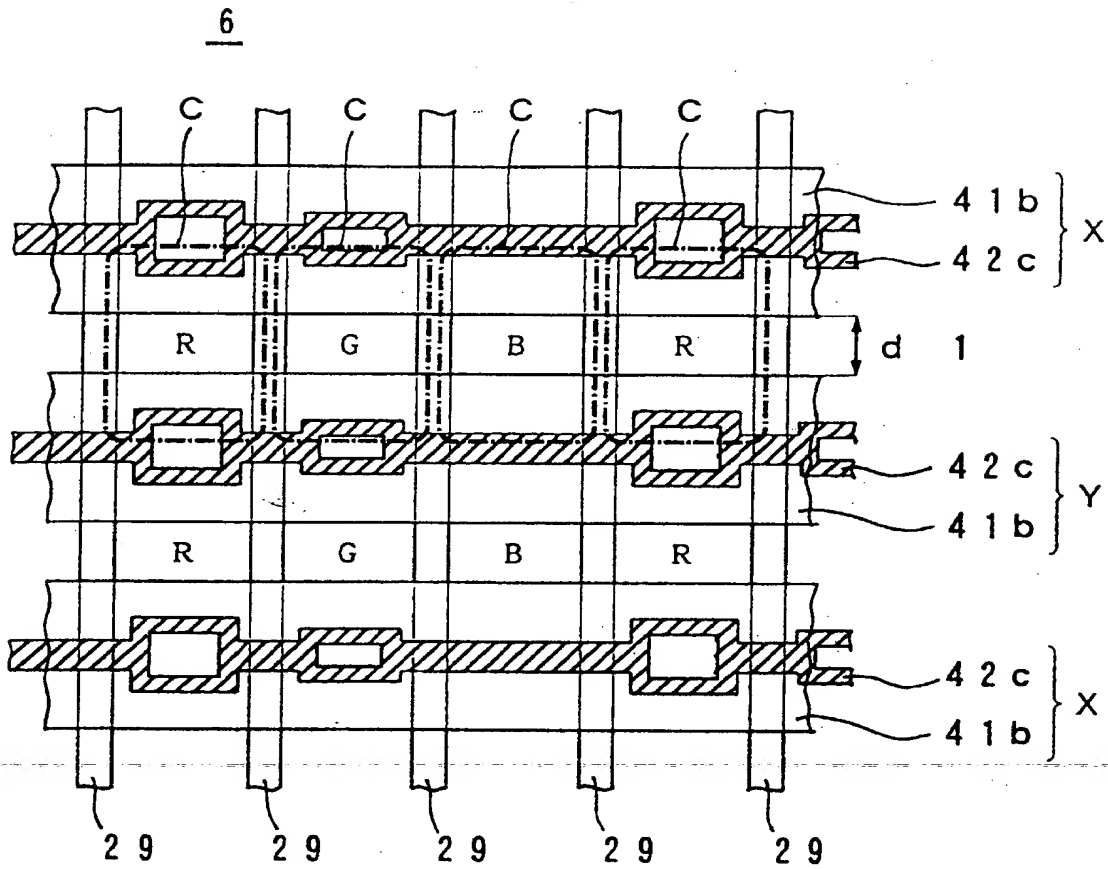




Fig. 15

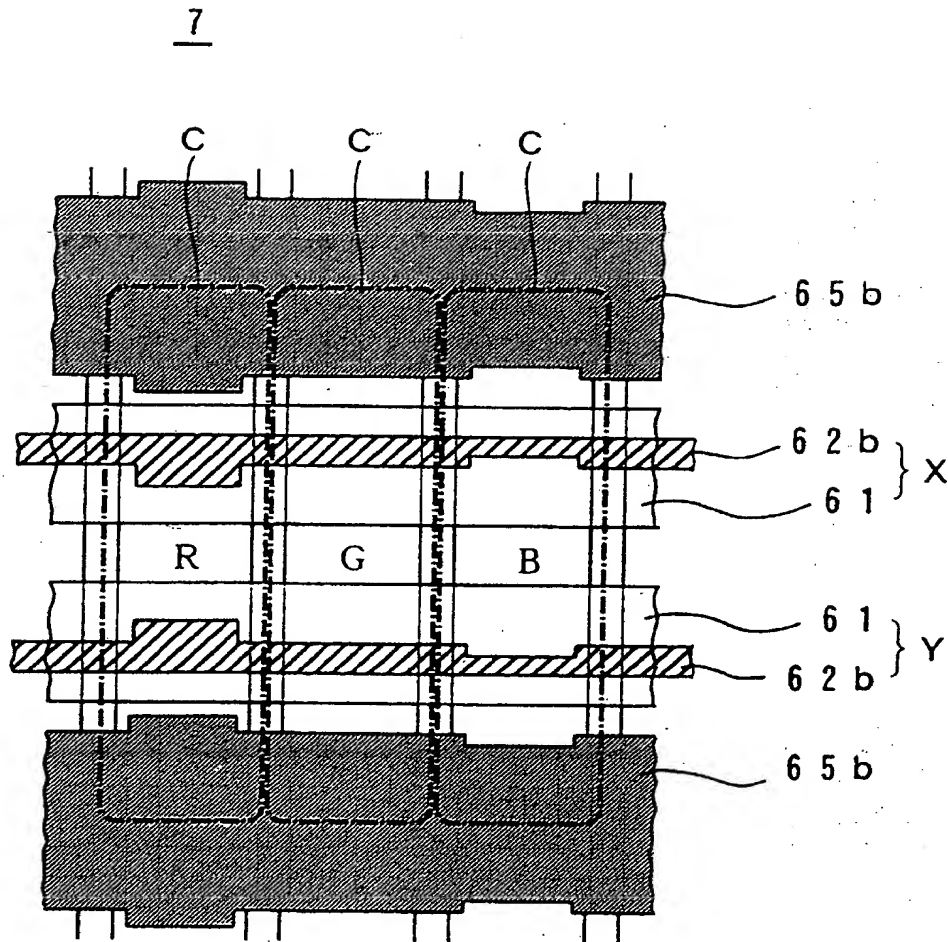


Fig. 16

8

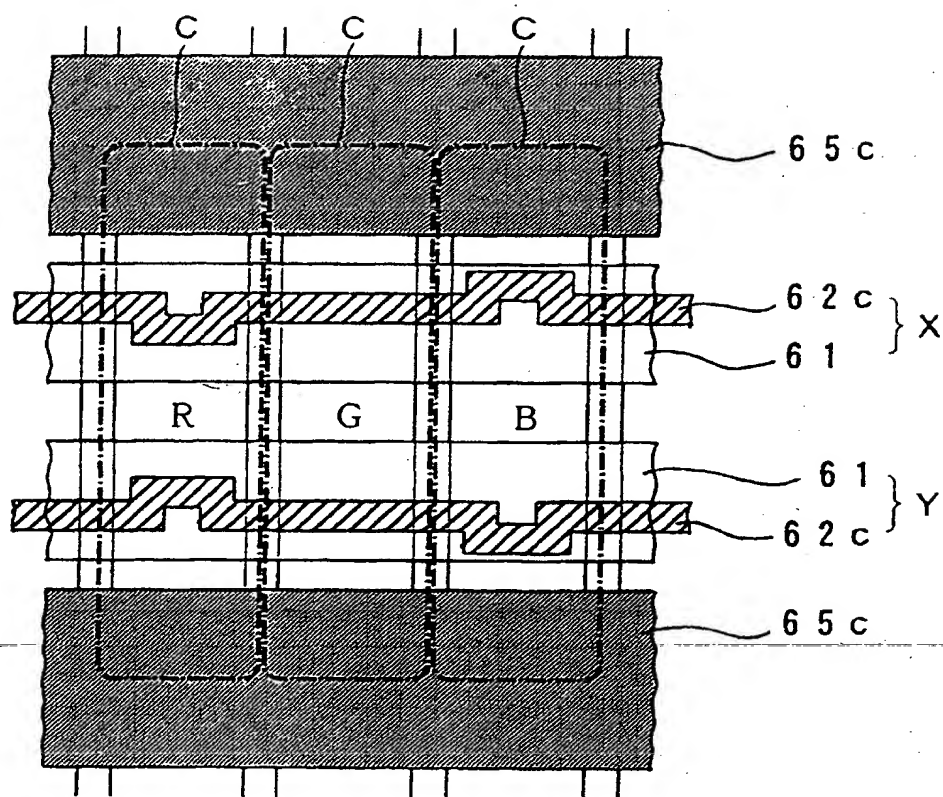


Fig. 17A

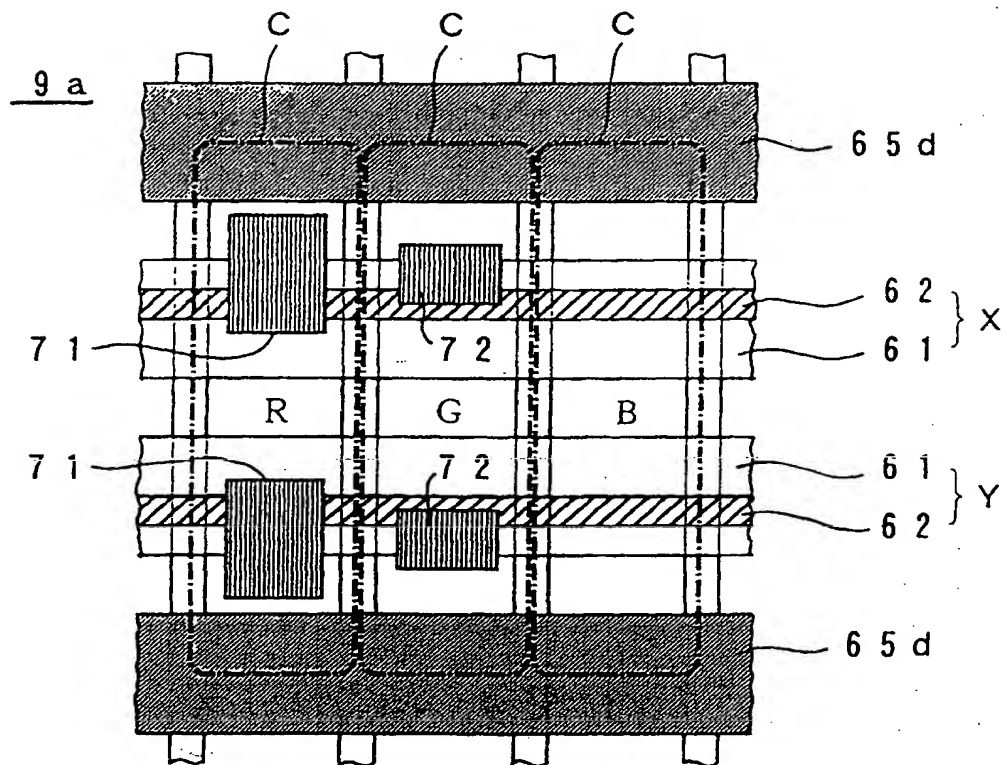
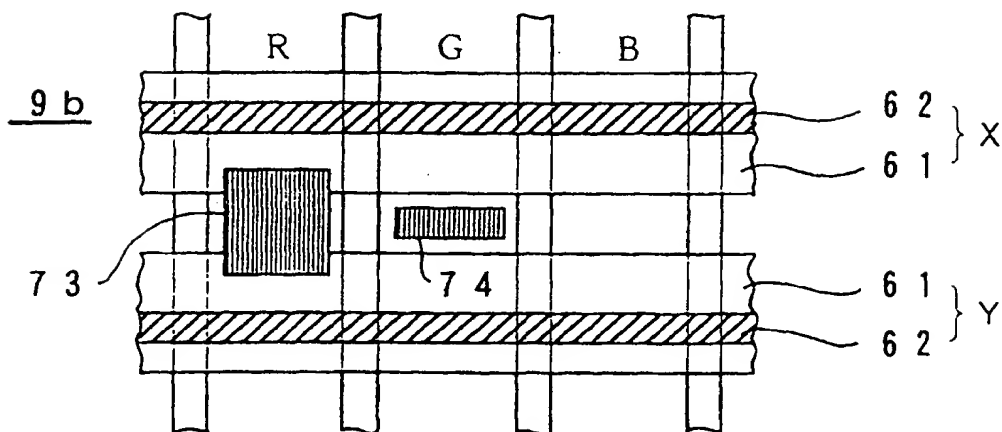


Fig. 17B





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(11)

EP 1 030 340 A3

(12)

## EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
02.11.2000 Bulletin 2000/44

(51) Int Cl.7: H01J 17/49

(43) Date of publication A2:  
23.08.2000 Bulletin 2000/34

(21) Application number: 99310058.5

(22) Date of filing: 14.12.1999

(84) Designated Contracting States:  
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE  
Designated Extension States:  
AL LT LV MK RO SI

(30) Priority: 19.02.1999 JP 4083799  
30.06.1999 JP 18460999

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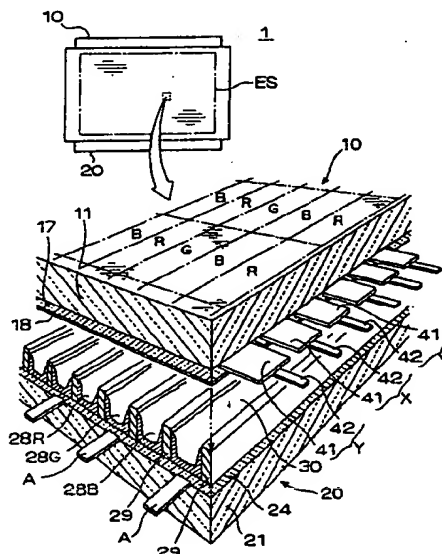
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## (54) Plasma display panel

(57) A plasma display panel is provided in which color temperature of the displayed color can be optimized while securing the gradation reproducibility and the stability of driving. The plasma display panel includes a screen in which a plurality of cells arranged in rows and columns emits light by electric discharge between a pair of main electrodes, and each pixel of matrix display has first, second and third cells having different light colors. At least one of the effective area of the main electrode, the thickness of the dielectric layer, the relative dielectric constant of the dielectric material, and the area of the light shield for the first cell is different from that of the second cell.

Fig. 1



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European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 99 31 0058

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
E	EP 0 966 017 A (FUJITSU LTD) 22 December 1999 (1999-12-22) * page 7, line 41 - line 53; figure 9 * * page 8, line 14 - line 19; figure 11 *	1,2,5,6	H01J17/49
X	WO 97 11477 A (ORION ELECTRIC CO. LTD.) 27 March 1997 (1997-03-27) * page 5, line 33 - line 35; figures 3,4 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 04, 30 April 1999 (1999-04-30) -& JP 11 007896 A (DAINIPPON PRINTING CO LTD), 12 January 1999 (1999-01-12) * abstract *	1	
A	US 5 587 624 A (KOMAKI TOSHIHIRO) 24 December 1996 (1996-12-24) * column 3, line 52 - column 4, line 5; figures 6,7 *	1-3	
P,X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 08, 30 June 1999 (1999-06-30) -& JP 11 067099 A (NEC CORP), 9 March 1999 (1999-03-09) * abstract *	2,3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01J
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 13, 30 November 1998 (1998-11-30) & JP 10 228870 A (HITACHI LTD), 25 August 1998 (1998-08-25) * abstract *	4,7,8	
A	US 5 818 168 A (USHIFUSA NOBUYUKI ET AL) 6 October 1998 (1998-10-06) * column 12, line 64 - line 67 *	5,6	
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>8 September 2000</b>	Examiner <b>DE RUIJTER, F</b>
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document		T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document	

EPO FORM 1503 03/82 (P04C01)



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Application Number  
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**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:





European Patent  
Office

LACK OF UNITY OF INVENTION  
SHEET B

Application Number  
EP 99 31 0058

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claim : 1

Size of cells independent of colour.

2. Claims: 2, 3

Variation in thickness or relative dielectric constant of dielectric layer.

3. Claims: 4-9

Variation in area of light shielding layer.

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 99 31 0058

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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08-09-2000

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

